OHMS

Geological Notebook

No. 34

Western Victoria

Museum of Victoria

Melbourne,C 1

Victoria, Australia

Western Victoria

Notebook 34

Please return to Edmund D Gill

National Museum

Russell St., Melbourne

Victoria, 3000

1/47 Wattle Valley Rd.

Canterbury, Vic 3126

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181 Fossil Channel S. Beach Pt. Fairy

Survey See p. 170 C14

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188 Moriac (Ctg. Princes H'wy)

P 135 for Bay numbers

Page 1
13.1.71
Childers Cove Area
Baylet E of Sandy Bay.

Section pp 2-3
Map of Sandy Bay showing fossil shore platform
Fossil nip runs normal to the coast

p.2 * classically regarded as Pliocene but is more likely a soil accumulated in a Glacial after a platform cut in limestone during an interglacial

Page 2
13.1.71
Four Formations
Vertical cliff section showing aeolianites and palaeosols

Page 3
Vertical section continued to Miocene marine limestone with platey concretions

Same stratigraphy all along this coastal with the expected local changes. S.L. = top of Durvillea Zone approx. (a little above c 6”)
Zone A is a well- defined bed traceable for miles. It

Page 4
is characteristic for a gap to be eroded between it & the layer above. At the W. end of Sandy Bay, on the largest island, there are caves just above this layer.
Diagram of Last Interglacial Hopkins estuary
Thus this fossil quadrilateral inlet is like the present ones, with straight sides.

Page 5
Diagram Fossil shore Platform

Page 6
(1) Fossil shore platform cut in MML with
- (a) Nip with pittings and at top honeycomb-like holes as on present shore. Nodules stand out on nip surface. Runs N-S
- (b) Runnel filled with conglomerate
- (c) Conglomerate 1’-2’ thick composed of shore pebbles (rounded & flat) formed from calcrete concretions, ~~A few~~ ironstone modules, pieces of rhizo concretions and shells. (Subninella Limpets, Dicathais, Haliotis “Monodonta”) which are mostly broken. Many worn & some bored by marine borers.
  A fallen block of aeolianite had a Subninella in it.

Page 7
(2) Fossil TALUS. Too high in diagram proportionately ~ 20’ x 15’ Consists of clay, sand, aeolianite (to 4’ diam), calcrete (incl. rhizoconcretions) ironstone nodules & a pebble 2” diam (& iron oxide).
Mostly soft but some indurated areas. Pre-dates the soft aeolianite. This appears to have been blown up by westerly winds.

Page 8
N-West Sandy Bay
See Book 2 p.1 Jan 1948
At the west end of Sandy Bay there is a comparable fossil platform & nip with talus.
Diagram Vertical section showing Talus of clay, sand, MML concretions above the platform
Platform of similar height to that at the other end of the Bay, but survey to be sure.

Page 9
Sandy Bay Islands
Map Sandy Bay Islands and location of western platform

Page 10
Caves on Island (p.9)
Diagrams: Caves on Island (p.9) and a triple platform (as marked on p9)
Even on a calm day there are waves breaking over these rocks & they can be reached only by rope ladder or other aid.

Page 11
Shelly Conglomerate cf. that published from near Guano Cave

Emerged platforms cf. those published in Two Mile Bay paper (with G. Baker) & the paper on Peterborough to Pt. Fairy coast.

Page 12
Geological History of Childers Cove area
1. Emergence from sea of Miocene limestone.
2. Reduction of surface by weathering so developing karst and emplacing the clay – apparently a lag deposit. At Pt. Campbell contains evidence of lateritization. Here the deeply leached zones, mottling, & ironstone may be evidence of it too. This clay very compact. Deep red in places.
Age: Pliocene
3. Pleistocene paleosol on this clay. Note change in depth of the weathering front.
4. Last Interglacial tentative history based on theory that four levels of the sea as the sea retreated – 70', 45', 25', 10'
(a) When sea 70' high

Page 13
Warrnambool Aeolianite planated at 70' above S.L. Edge of basalt plain trimmed e.g. at White's Lane, W'bool & between Tooram & W'bool (there being a bay there then). Sea retreated & left Aeolianite 1. Also Cannon Hill dune which then reduced by soil formation.
45 ft. Low hills near W'bool Woollen Mill etc planated.
Site of Allansford eroded?
Tooram. Aeolianite 2 emplaced over Aeolianite 1 soil.
25ft. sea. Formed or completed Crossley Scarp, cliff & platform at W. W'bool, deposited Pt. Fairy Calcarenite Portland to W'bool, formed sites of Pt. Fairy and Dennington.

Page 14
As sea retreated left beach ridges Yambuk to Killarney & dunes Illowa to Burnie's Beach.
10 ft. sea Platforms, nips, shelly conglomerates at Sandy Bay, Guano Cave coast, Two Mile Bay etc. These previously regarded as 25 ft. shores tectonically flexed & this may still be correct. Moreover, the Two Mile Bay deposit is the only one dated, being beyond the range of 14C and having Ninella torquata.
Aeolianite 3 was clearly emplaced after the 12' platform at Sandy Bay. Nos 1-2 are covered by the Last Glacial

Page 15
calcrete

Page 16
Former River Debouchement
Diagram of former entrance of Hopkins estuary
Sandy Bay is sandy bec. the MML has been cut to below SL and then infilled with later deposits – cliff talus, dunes and such like. The fossil platforms & nips run NS showing the sea entered this valley at that time. The marine shells on the platforms are open ocean rock types.
The valley is too large to be of a local creek and must represent a river of good size.

Page 17
Bec. the valley is cut below SL it ran during a Glacial, evidently the last judging by its freshness, & the lack of an old soil on the sand infill.
From the Hopkins River at Allansford a linear depression that appears to be an old river course runs along parallel to the coast eastwards just as at present it now does westwards. It seems to be a

duneline diversion & the construction of the Last Interglacial dunes may have caused this. This dune at the present Hopkins mouth is exceptionally high & wide. If the river were diverted in the

Page 18
L/IGl then it would cut a valley during the L/Gl. Boring could establish this or a geophysical test. There are soft sediments in the ~~valley wall~~ river bank of the Hopkins where the depression leaves the present course that could be old course fill.

Page 19
13.1.71
Mernane's Bay
On the E. side of Mernane's Bay are many fallen blocks of aeolianite which crowns the cliff above. One block on the cliff top is poised for fall, being broken along a fracture plane with a 9" gap and resting on a narrow ledge. Inferred that it has moved very slowly to its present position or its momentum would have carried it away. Support is removed by fall of other blocks, by wind & water erosion and perhaps by compression & flowage not possible when there is no free face.
Other cracks are present & so preparing for future block falls. Such cracks

Page 20
are apparent all along the coast in both MML and PE (Pleistocene aeolianite), although the patterns and processes of spalling are not the same. However, it is clearly the main process of cliff demolition.
Fallen Blocks now form artificial stacks in Mernane's Bay (where furthest out), small platforms (where oldest & planated), and a rock fall talus.
Platforms covered with Hormosira sea lettuce, Caulerpa, white tufts, brown/green tufts, white calcareous algae. At outer & inner edges where not covered with algae are Galeolaria, chitons, limpets etc. Durvillea on exposed edges. Pink tufts.

Page 21
Fallen Block with Shore Platform
One of the fallen blocks at Mernane's Bay on E side near L.W.L.
Diagram: Plan of the fallen block
Platform is thus widest where exposed. Taken as a whole this is true, but rock variations & differences in history provide exceptions.

Page 22
Diagram: Elevation of the fallen block
The S face may have been a joint or fracture plane as it is so regular.
Landward of above is a much bigger block with 6'6" platform at SW corner. Tunnel 2' in diam. in middle of outer (W) edge. Gives idea of rate at which solution works (and abrasion) to form tunnels & platforms. Cups 1'6"-5' diam. 2'-5' above platform. Lower ones have patches of minute

Page 23
black (& a little red) mussels on the cup floors.

Page 24
14.1.71
Bushfield
Black bones collected from the Merri River. Appear to be as numerous as when first collection made. Supply is therefore continuing. Marsupials mostly but also rats, birds and ? reptiles.

From where road ends to fossil site no bones found. Also where can be seen, the tuff extends below water level therefore:
1. Original valley floor lower than now.
2. Thickness of tuff varies
3. Excavation where bones originally found was apparently on to a river terrace. This a likely place for a midden.

Page 25
It should therefore be possible to reach the deposit through the valley wall.

Page 26
14.1.71
Merri Island
NE. corner has arch
NW. corner is heavily cracked as a result of collapse from cave & undercut.
Middens on top of cliffs all round the island.
Dip landward ~ N of rocks of island & shore platform.
NW corner also has a cave & arch
Platform on W side cracked & collapsed in places due to extensive undercut. Thus some blocks sloping sea-ward that are partly out of the water at low tide & partly submerged. Further out is an older generation of collapsed blocks that are completely submerged. cf E of sewer outfall W'bool, & the Craigs.

Page 27
Platform collapse also at NE corner. Can see platforms between Merri Is. & Pickering Pt. once joined up. Destroyed by collapse and not ~~ab~~ erosion.
The S exposed side of the island is the highest. A channel leads into a large cave, wh. has collapsed leaving a high pile of broken blocks. Along the SE side of the channel is a "bar" 10'-15' wide of platform cracked.
From here can see large cave in Middle Is. with thin cover of rock.
Collapse
1. Increases the rock/elements interface & so increases erosion rate.

Page 28
2. Shifts rock from the slow erosion zone of the cliffs to the high erosion rate of the surf zone.
3. Brings rock under new types of erosion e.g. biologic, wetting & drying.
Cliff top stripped to calcrete zone on S (seaward) side of island which some sand accumulation & vegetation growth on the S (landward) side.
Tuff 2'3" thick on E side of island, also stripped.

Page 29
Cave Collapses
To show the significance of this factor in cliff demolition a survey was made over the coast from E side of Thunder to Pickering Pt., W'bool.
1. Table Cave
2. Very large collapse fenced in bec. of big overhang & steep cliff below it.
3. Another large collapse used as a picnic bay.
4. Smaller & older bifid collapse.
Diagram: plan of 'Y' shaped cave

Page 30

Then 2 small ones not counted. Stacks and cups here.
5. Arch & cave collapse fenced off. Collapsed in recent years. Photographed Notebook 33 p.115
Soft sand on top then platey accreted zones increasing in occurrence downwards. These apparently caused by downward percolating rain water. Fully indurated round cave walls due to sea water. Thus some induration due to rain water but not such as to determine a shore platform. A bore at Warrnambool Woollen Mills had salt water. This plugged off & fresh water found deeper.
6. Large Shelly Beach curved embayment

Page 31
6. Cont'd. Cliffs at their lowest at Shelly beach – about 10'. Calcrete top up to 3' thick with soft sand below which is eroded by sea causing collapse. So fallen blocks here not of aeolianite, as is usual elsewhere, but of calcrete. They are thus smaller & of diff. character. This factor also affects morphology of area wh. is a broad(c 4 ch.) curved embayment with a beach of sand, shells & pebbles – hence name & favoured for picnics when not too much collapse. Cliff rise at each end.
7. Well-formed bay about 2.5 ch. in diam. Old collapse, so many of the fallen blocks have been destroyed.

Page 32
May have been two caves
Diagram: Plan of the two small bays
Thus a continual series of bays formed by cliff collapse over caves and undercuts, which are much the same process.

Page 33
17.1.71
Gorman's Lane
and Tower Hill Beach
Diagram of Beach showing road and 2 dune lines with features 1 to 4:
1. Blocks of tuff & basalt form beach ridge.
2. Middens on dune
3. Inner beach ridge like 1. Same structures as near Merri Ctg.
4. Diagram of soil profile in dune line 2:
Marram grass
2' fawn sand blown up recently
5' dark gray soil with midden shells. Flint implement coll. (secondary chipping)

Page 34
Shows
1. Dunes almost as high as now before marrow grass introduced. Further E capping sand thicker in places.
2. Dunes stable so that soil could form. Date by midden shells, midden charcoal or organic matter in soil.
3. Soil thickness suggests a little accretion during occupation, as is also indicated by shells at various levels in it. This Aboriginal occupation therefore during final phase of construction of Dune 2.

At Tower Hill Beach site near Merri Ctg wombat teeth & bones found in situ in lower soil.

Page 35
18/1/71
McKechnie's
~~The~~ Craigs

Reached through “Oakvale”. No basalt on this coast except for pebbles brought by Abos. (in middens). Soft aeolianite indurated to form cliffs. Fallen blocks characteristic. Soft sand higher up – stripped calcrete layers. Mobile sand beyond.
Middens all along coast – rock shells & charcoal (usually finely divided) some high in cliffs & fewer lower near beach. Bones & implements rare. Some groups of cooking stones still in place after deflation. Pieces of (with Tertiary marine fossils) flint.
Paleosols a feature of the cliffs.

Page 36
Two zones of well-developed rhizoconcretions (photos) Near former Goose Lagoon outlet three large rock falls since there a year before (Jan. 1970). Cracks in cliffs common. Ramps of pebbles. About 150 yds from the First Craig (outlet formerly of Goose Lagoon) burrows at contact of aeolianite & paleosol.
Diagram: Vertical profile showing burrows

Page 37
Large midden in sand at top of cliff about 200 yd. from first Craig. One of the few places where the middens are not completely blown out and a residual remains.
Cooking stones. A few basalt pebbles, no doubt from Cape Reamur.
Movement of sand in this area revealing a buried calcrete forest (photo).

Page 38
Diagrams. Maps of area W of Cape Reamur showing coast and fencelines of ‘Oakvale’ property.

Page 39
19/1/71
Cape Reamur
Diagram: Map of Cape Reamur
Collapse Structure
Diagram of the basalt layering of the collapse structure
Layers in situ with consistent dips:
1. Boulders with flow structures that weather to give a laminated appearance.
2. More vesicular zone, frothy in places
3. Solid basalt

Page 40
Diagram: Map of Cape Reamur(continued)
Marine erosion related to structure
Diagram: Map of basalt structures in headland at Cape Reamur

Page 41
Diagram of columnar basalt
Columns of basalt at tip of boulder point. All the rocks of the S tip of point are in situ & columnar.
See p. 103
As L/IGl sea retreated, left calcareous sand over sea-eroded basalt just as shell sand at present fills cracks of in situ basalt & lies between boulders or forms continuous tracts of its own. Last type formed bed of limestone while the other formed cement between rocks. Top c.3’ became a terra rossa during the Last Glacial when the shore remote.

Page 42

Thus the terra rossa on the aeolianite & the humic podsol at Port Campbell are contemporaneous (L/Gl), the one formed on calc. sand & the other on quartz sand, the one alkaline and the other acid.
Honeycomb-like pittings in basalt away from wash zone. Far more numerous & complex than any ga~~ss~~ alveoli as can be seen by breaking rock & comparing inside & out.
Two generations of boulders – the Last Interglacial ones cemented in the limestone & the present generation. Some very large boulders – pieces of columns w rounded corners. The largest seen calc. as ~ 100 cub. ft.

Page 43
Lava Blisters
Tumuli
Diagram: Map of two lava blisters.
Domes of basalt. Outward dip of 15^o measured. Laminated appearance

Page 44
20.1.71
of top layer due to weathering of flow structures. Series of layers here same as in collapse structure at point.
See Blackburn, J.A., 1969. Our vanishing geological monuments. Vict. Nat. 86:130-131 Figures & lava blister at Williamstown.

Page 45
Reamur Calcrete
Diagrams Map and vertical elevation of Cape Reamur area showing calcrete position and elevation.
Height of calcrete outcropping on beach. Inland in places it rises as high as at the Craigs ~80'
Calcrete laminated & mammillary in places as at Dennington, Middle Island

Page 46
21.1.71
Goose Lagoon
Auger hold 6 (continuing numbers from Book 33 pp.77-8) about middle of swampy flat on S side of Princes Highway opposite telephone pole 3R/61 and 15 ft. S of S boundary of road. Colours wet:
0' – 2'6"   Dark-brown almost black peat. Root at 1'6" Water at 2'6"
2'6" – 8'9"   Same with reddish-black fibrous plant material. Too much water and too fine material to go deeper. Samples washed out of auger head.
Low cliff in calcrete on W side. On S. & SE. sides oversteepened slopes in L/IGl dunes due apparently to cliff formation when a lake was present there.

Page 47
Yambuk
Map of Yambuk Lake area
Bar at mouth & calcrete with marine shells on E side. Very low dips. Pitting like honeycomb on the undersurface
(from p48)
1. Available when others not bec at MSL Brachidontes rostratus mid tide shell
2. Sometimes cover platform cf at mouth of Hopkins

Page 48
of overhangs (sample) as at Middle Island & elsewhere.
Shore platform also low dips suggesting beach & shallow water environments. Deep undercutting and channelling (6'-10') with boulders. Many deep holes in platform. Diff. from aeolianite at W'bool

& elsewhere. Presence of platform at river mouth suggests water percolating through has increased speed of induration.
Significant for study of shore platforms in general.
Middens on W side of mouth on terra rossa & calcrete. One area with thousands of red mussel shells.(see page 47)
In right river bank

Page 49
soft sand over terra rossa with gray soil & midden as dated 2500 at Levy's Point.
In this river bank calcrete development varies greatly. Near sea mass of calcrete of fossil soil & rhizoconcretions form complex up to 10' thick, making a shelter.
Mixture of sand & rock shells in middens but the great majority of the latter facies. Imported stones mostly flint & basalt. Some fireplaces with cooking stones. No implements found. Strong wind made conditions unpleasant.
Photo: Honeycomb in l'st of shore platform at Yambuk.

Page 50
22.1.71
Port Fairy
Map of Botanic gardens area showing basalt outcrops a low platform and location of auger holes 1 and 2

Page 51
Auger 1   1' of mud then rock prob. basalt.
Auger 2   On grassed flat ~ 3' above samphire flat and covered by 1946 flood.
0"-8"   Mid-gray sand. Juvenile soil.
8"-2'   Light-gray sand with some shell fragments.
2'   Same with strong brown mottles and a higher % of carbonate. Nodules formed from shell sand.
A hard layer prevented further boring.
Estuary has a basement of basalt which protrudes in places as outliers. The Port Fairy Calcarenite has been stripped of it & replaced by Holocene calcareous sand & alluvium.

Page 52
Moyne Estuary
Map of Botanic gardens area showing basalt outcrops a low platform and location of auger holes 1 and 2

Page 53
Griffith Is
and E. end S. Beach.
The east-west coast between Port Fairy & Cape Reamur is out of character in direction to contiguous areas. This is due to the Woodbine Basalt flowing S down the valley of the ancestral Moyne during the Penultimate Glacial.
Along this stretch of coast the outcrops are of this basalt with remnants of superposed rocks. The area of outcrop is narrow as a rule, but at Griffith Is. (S. coast) vicinity the area of outcrop is exceptionally wide. The reason was sought and interesting structures discovered.

Page 54
Folded Map of Griffith Island area showing dip of basalt structures

Page 55
Diagram Griffith Island – South beach coast showing basalt dips(cont'd page 56)

Rough diagram of structures
1. Western Passage appears to be a collapsed lava tunnel, while
2. Circular structures 1-6 appear to be lava blisters.

Page 56
Diagram Griffith Island – South beach coast showing basalt dips (cont'd from page 55)
The structures need to be surveyed. Dips 15°-30° shown by joint planes, bubble trains, flow structures and layers of frothy basalt between more solid layers. The structures are closely comparable with those at Cape Reamur.

Page 57
8.12.68
(out of order)
Peterborough
Diagram: Vertical section of cliff showing rock layers
Series of potholes & blowholes in a row – a band of suitable limestone. Concretions armour the platform.

Page 58
23.1.71
Warrnambool
The elimination of the sharp bend at Battarbee's Corner on the Princes H'way & the provision of a two-lane road resulted in deep cutting at B's corner. Between the original road & the present lower one there is a section c 15' high which reveals a deposit of Tower Hill Tuff not known before. The batter has a slope of 50° and the following is a hard sketch thereof with a number of measurements for control. A chain tape was laid along the base of the cut & a 3' clinometer rule used for the other measurements.

Page 59
Diagram: geological section of the road cutting
Generalized slope of contact of tuff & l'st, 30°
Dips in tuff measured 8°, 11°, 18°. Disturbed near contact. Fine & coarse; cross-bedding Deposited in lee of hill.

Page 60
1. In Last Glacial weathering of Miocene marine limestone to form terra rossa. Hill already there as a result of stream action – Russell's Cr. ~ 70000 to 10000 y BP
2. Most of the terra rossa stripped off in the Lower Holocene before 7300 BP
3. Tower Hill Tuff emplaced.
4. Three feet of blocky black loam developed between c.7300 y BP & now.
5. Soil pipes formed, prob. initiated by trees and in some cases by burrowing. Long one at 20' has parallel sides 15" apart. cf. tuff infillings & fossil terra rossa at Dennington.

Page 61
Snails
1. Theba pisana (Muller) in calcareous dunes
Drawing of T. pisana (anomphalous)
2. Helicella caperata found with above.

Drawing of H. caperata (umbilicus present)
3. H. virgata & H. neglecta
closely related, & found in drier parts of W. Vict.
4. Cochicella ventrosa = former Helicilla barbara. For this species see Pt. 2 of –
Smith, B.J., 1970. Vic. Non-marine Moll, 3 Vict. Nat. 88:45 (Deals with 1-3 above).

Page 62
13/2/71
Two Mile Bay
W. of Port Campbell. Tide in. Much erosion since there last. Dune blown out. Platform destroyed at E end. Much eroded in middle. Did not get to W. end.
This comparatively rapid wear means that originally the platform must have been a very wide one. It is certainly a much bigger feature than any Postglacial one in the area, so it may be inferred to have lasted much longer than the latter.
Middens with cooking stones of calcrete, limestone & shell rock. Some flint flakes. Numerous shells of rock facies. Charcoal.
Seal seen in turbulent sea.
Where L/IGl platforms occur prob. in old bays & so protected. Stripped by 10' sea – hence juvenile soil.

Page 63
13.2.71
Hopkins Estuary
High dune on E side may be due to sand migration – dune built over older stump up slope as in cliff-top dunes. Large pieces of aeolianite included in base may be of such an origin.
Shells collected from beach bed at base of cliff near river level.

Page 64
E of Stanhope Bay
Diagram of flat shore platform
Flat because
1. Water sheet erosion
2. Vertical cleavage & vertical spalling of cliff & platform edge
3. Solution from flat water-layer.
4. Profile of equilibrium. Cliff & plat. edge retreat before platform get more reduced.

Page 65
Diagram: Vertical section from Stanhope Bay to Burnie's Beach
Horizontal beds not in Stanhope Bay or Burnie Beach section. Limited to narrow area – a bay?
Diagram: Vertical section showing Aeolianite and MML
"Horizontal" beds have small seaward slope. Measure, but drop 20' to 50?
Found small piece of australite button & gave to Dr. Agrawal.

Page 66
13.2.71
Sandy Bay
Diagram: Vertical section showing erosion of aeolianite dune by post – glacial sea.
Calculate distance A-B and volume of rock removed. Compare calculation from cliff top dune with that from SL dune at Warrnambool.
Always a paleosol in middle of dune (or may be sub-divided). Interglacial in two stages 70' and 25'?
If marine planation before dune emplaced then clay eroded away.

Page 67
14/2/71
Breakwater Is. or Rock
Large crack on E side enlarged since January
Diagramof rock platform on Breakwater Island
Platform in old age with extensive pools & cracks.

Page 68
On the sheltered side of the island near groyne there appears to be more solution & less cracking. There are wide pools in the platform and many channels. Cuesta type island platforms – effect of N. dip.
Parallel between collapse of parts of platform as p67 & collapse of parts of cliff when undercut. A limestone platform is undercut & overcut.
Storm Waves very heavy along here & Port Campbell coast yet no storm wave platforms.

Page 69
Earthy & Crystalline Carbonate
NaOH put out for ^{14}C check sometimes powdery precipitate of sodium carbonate & sometimes crystals. (Dr) Agrawal suggests crystals form as a function of temp & humidity (less water encourages crystal growth). Will check this.
If so, we may have explanation why earthy carbonate (sometimes in solid bands so appar. quantity is not a factor) in some places & crystalline nodules in others.
Diagram of dispersed and nodular carbonate

Page 70
1. If enough rainfall to move carbonate down profile but not wash it away then earthy deposit.
2. If amt. of water reduced (lower rainfall, greater acidity) then crystals grow.
If the foregoing correct then form of carbonate deposition is a climatic indicator.
Thus the crystalline mammillary calcite over the L/IGl calcrete may indicate a drier period at the end of the time of deposition.

Page 71 and 72
Thunder Point
Map of shore platform showing cracks and pools (cont'd over to page72).
Demolition of a Platform. Except for slow deepening of a large surface pool & trimming of edge no change noticed over c 40 y but now rapidly disintegrating. Processes are (1) cracks causing foundering. (2) Pools deepened to stage where become rock reservoirs and so abrasion centres.

Page 73
(3) Also pools deep enough to grow large & small seawards. Meadow & forest of algae assist solution. (4) Accelerated reduction of pool results in accelerated gradients for water-sheet erosion and channel erosion. Latter operates continually & is the more effective for reversing with every wave wash.

Page 74
Middle Island
Warrnambool
Photo Middle Isl. Merri Is. & Pt. Pickering
Photo Stack on channelled platform
Photo Looking fr. Middle Is. past Merri Is. to Pt. Pickering

Photo Wide platform in embayment on E side of Middle Is. generated by a series of cave collapses.
Photo Recent cave collapse on N side embayment on E side. Note also cavitation solution (?taffoni) & tunnels.
Photo Cave collapse on W wide of same embayment on Middle Is. Cave collapse appears to be the dominant factor in cliff demolition & edge fracture that in the shore platforms.

Page 75
14C Tower Hill Tuff
Diagram of Table Cave area showing location of C14 sample
C14
Gak – 2856, 7300 ± 150 y B.P.
Midden shell cut from tuff.
Dr. A.W. Beasley says heavy fraction of matrix ~~includes~~ consists mainly of olivine, augite, black opaques (iron ore). Many of the grains are very angular & the degree of sorting is low.
1. These middens with marine shells show the sea within reach. Probably level a little lower than now & dune ridge probably complete as far as

Page 76.
Pt. Pickering Midden
beyond Middle Island. Perhaps the eruption cut off the exit of the Merri at The Cutting & forced it back to the route followed when Europeans first arrived.
2. Show Abos there during eruption, & habit of coll. sea food much as now.

Page 77
Buckley's Swamp Mortars
Grinding Stones
Photos of X75223
Diagram: surface of grinding stone
Top surface covered with nodules (- 1cm but usually less) like buckshot but is non-magnetic.
Underside has another cup but no nodules However, all the rock

Page 78
very weathered.
Brought to Museum by Chas. E. Hingston (Govt. Carrier) on 12/2/69 (Docket 1949F)
One of a large group collected by Farmer Allan Lewis (See Notebook 27 p.170 for map) on the E side of Buckley's Swamp & acquired by K.L.M. Elmore for the National Museum.

Page 79
Capt. Cook & conchology
Dance, S. P. 1971 The Cook voyages & conchology
J. Conch. 26:354-379
Collected by Cook from Australia
Haliotis (notohaliotis) ruber (Leach)
Cellana tramoserica (Holten)
Austrocochlea obtusa (Dillwyn)
Ninella torquata (Gmelin)
Subninella undulata (Lightfoot)
Nerita punctata Owoy & Gaimara
Nodilittorina pyramidalis (Owoy & Gaimara)
Bembicium melanostoma (Gmelin)
Dicathais orbita (Gmelin)

Mimachlamys asperrima (Lamarck)
Ostrea angasi Sowerby
Crassostrea commercialis Iredale & Roughley
Anadara trapezia (Deshayes)

--
--
141 species

Page 80
Biota
1. Provides protection
Durvillea has fauna found only in relative protection of holdfasts.
Limpets cover. % of rock
Hormosira & other algae cover rocks
Coralline algae give good protection
2. Biota erodes
Boring organisms
Burrowing organisms
Grinding organisms
Dissolving organisms

Page 81
15/1/72 Sat.
Me(u)rnanes Bay
W. Vict.
Photo: East side of bay. Aeolianite Paleosol that yielded Procoptodon. Therefore Pleistocene but structures poorly cemented when not exposed to sea, so L/IGl which is the date assigned by analogy
Photo: Aeolianite Undercuts due to calcrete top & greater lithification nearer surface. Softer aeolianite below. Excavation thereof leads to large overhangs followed by large Rockfalls.
Photo: E. head of bay consisting of Miocene marine limestone, to c.40' above SL
NB MML Has platform similar to aeolianite viz Flat/wide, intertidal, notch present, narrower in protected places – Undercut & so retrogradation by cliff falls.

Page 82
Photo: Pocket beach & near vertical cliffs.
Rock falls. Aeolianite rises above general terrain level.
Photo: Flat terrain ~ 70' above SL
Labelled: Beach, Surf, Sea
Photo: View from seaward side of Mernanes Rock
Labelled: Fallen block of aeolianite, Mernanes Rock, Durvillea (top=MLW) on old eroded block.

Page 83
Mernanes Rock
Wilbur Mathieson says some rocks in this bay have local names but not this one.
Photo: Land ward side with notch & narrow platform
Seaward side with wide platform (- 6')
Intertidal. Top of kelp = MLW
Photo: Sharp edges & steep recess in near about homogeneous rock means solution dominating. Limpets make use of the hollow.
Photo: Holdfasts exposed by very low tide. Tidal Range c.3' springs

Page 84
Photo: Shore platform on fallen aeolianite block.
Labelled: Mernanes Rock viewed from seaward side, Similar platform on larger block, Blocks reduced to platforms, so may be older blocks – or perhaps just more exposed., Kelp, top of which = MLW level.
Photos taken just after low tide.
Evidence of solutional action
1. Pits with sharp edges like honeycomb.
2. Sharp corners of blocks in the limpet zone as opposite
3. Sharp protruding points left. Erosion would round such.

Page 85
6 unlabelled Photos
Large fall of blocks below middle of arc traversed by the terra rossa paleosol suggest that it was sapping along same that initiated the big cliff collapse. It will probably be a long time before another of similar dimensions occurs. The Miocene marine limestone forming the base of the cliff erodes fairly evenly having no such internal structures to precipitate rock falls into the sea.

Page 86
15 unlabelled Photos Childers Cove area
Dennington Sand
Paleosol 1
Paleosol 2
Portland Limestone

Page 87
12 unlabelled Photos
Platform flat even though slight rise in sand landward & so a rise in the water there.
3 unlabelled photos of small stack

Page 88
Relatively smooth notch where exposed but deep solution pits & sharp edged “tafoni” to notch where sheltered (middle photo p.83 & below)
Photo showing splash etching and a solution notch
Photo: In protected areas solution dominates over abrasion. Close-up of solution pits

Page 89
Photo: Some blocks reduced to platforms.
Locals say no falls of large rocks occurred to their knowledge.
Photo: Aeolianite dropped from above so no groundwater effect. Diff. dips but make only minor changes.
Platform of Miocene marine limestone same flatness, height. Extensive. Must be many centuries old.
Photo: unlabelled of cliff and shore
Label on all 3 photos: M= Mernanes Rock
Low tide

Page 90
Photo: Massive fallen blocks of aeolianite at foot of cliff.
Photo: In situ Miocene marine limestone with flat shore platform, intertidal.

Similar flat intertidal platform in fallen block of aeolianite. Twice as wide on exposed side as elsewhere.
Photo: Seaward site of Mernane's Rock. Low tide. Top of kelp = MLW. Sandy floor.

Page 91
Photo: Cliff. Cliff top dune of aeolianite c.50'. c.30' Miocene marine limestone
Photo: Top of Mernane's Rock strongly spray etched.
Platform completely planated, cut from fallen aeolianite block.
Photo: unlabelled of cliff and shore

Page 92
3 unlabelled Photos of Mernane's Rock
Diagram of varying rock platform width
Direct relation between exposure & size of platform. Therefore abrasion a factor & not just solution. Indeed abrasion is the main factor.

Page 93
19.1.72
McKechnies Craigs
Photo: Travertine accretions in calcarenite clifftop dune, now wind-eroded. (tele)
Photo: Roots of shrub exposed to compare with rhizomorphs (tele)
Photo: Telephoto of Cape Reamur
Photo: Numerous fallen blocks along Craigs Coast
Photo: Clifftop midden sample coll. for C14. c 300 yd NW of outlet of Goose Lagoon.
Photo: Protruding ridge of aeolianite at McK. Craigs
All this page telephoto.

Page 94
Photo: Paleosols and Cliff falls on beach
3 Photos: Breakup zone in aeolianite platform betw. cliffs & outer platform. Island platform in the making.
6 Photos some with notes
Diagram: map showing location of photos near Cape Reamur

Page 95
Photo: Waves from different directions cross platform
Photo: Paleosol & heavy cliff falls. Looking SE to exit from Goose Lagoon
5 unlabelled Photos
Photo: Cliffs at the McKechnies Craigs.

Page 96
2 Photos: Platform breaking up & water running along cracks causing abrasion
Photo: Edges of cracked blocks sunk below water level
Diagram: interpreting this photo
Photo: Dark = undercut block
Photo: Tilted block

Page 97
Wed. 19.7.72

McKechnies Craigs
Cliff on W. side of former outlet of Goose Lagoon
Lower palaeosol in L/IGl dune cliff.
26” 2.5YR 2/4 Dark reddish brown loamy sand.
Sharp boundary to
15” Calcrete nodules earthy inside, smooth surface but may be mammillary. Not solid calcite as at Chowilla – softer. Top 4”-6” with soil as 1”-26”. Remainder 2.5 YR 3/4 dark reddish brown but lighter than above.
Nodules reduced at bottom so grade to
10” Same loamy sand without nodules. Over 10” or so slowly grades to

Page 98
26” Speckled light brown 7.5 YR 6/4 but no real match. Sharp break to
4” Dark red 7.5 R 3/6 loamy sand, then same with calcrete rubble lithified into a conglomerate which gradually lightens in colour to pink and off-white. This horizon varies in thickness but is typically about
2’6” At the base is wavy hard-pan of whitish calcrete leading to numerous rhizomorphs up to 2” diam. Between is light pinkish gray sandy soil with charcoal, very variable in colour & lithification so as to provide no meaningful Munsell notation.

Page 99
Since Jan 1971 (1 yr) small cavities & caves enlarged enough to cause collapse.
Shrubs in present cliffs have long thin trailing tapering roots as seen in calcrete rhizomorphs. No vegetation found with roots comparable to the vertical nodular ± 1” diam rhizomorphs which may not be root replacements. However could have different vegetation in a diff. climate.
This calcrete horizon runs below SL at Goose Lagoon outlet to SE while to NW rises to cliff top. Varies in intensity of development. Craggy section photographed has base (above beach) of finely bedded

Page 100
aeolianite with low dips in many directions – sand rises.
Horizontal paleosol above this:
~ 15” Reddish brown 2.5 YR 4/4 loamy sand lithified to various degrees, with charcoal & planospiral snail shells “Paralaoma”, grading slowly to light reddish brown 5 YR 6/3 to pinkish gray 6/2 to aeolianite & rhizomorphs.
Other forms of secondary carbonate beginning at c.3’.
Section at top of cliff like that at bottom but wavy calcrete horizon comes & goes. Intensity of rhizomorph development also varies. In one place a second layer of conglomerate

Page 101
below wavy calcrete. It varies from 15”-30” thick & has a 2nd wavy platey calcrete layer below ~~wavy calcrete. It varies~~ but much thinner 1/16”-5 ½”. This not continuous. At crest of cliff rhizomorphs well developed to 1’ diam. but of soft white travertinous mineral. Also masses that are probably channels of preferred soakage. cf top photo p.93 in what appears to be a Postglacial dune.
Structures of same age?
Aeolianite Platform
on W. side of headland with large midden c 300 yd NW of Goose Lagoon outlet breaking up by means of large usually straight cracks as shown pp. 94-96.

Page 102

Much breaking up between shore & outer part of platform. In process of forming an island platform. Lagoon already between shore & much of the platform; broken blocks under water. Connecting piece breaking. Undercuts up to 12" measured but no survey done.
Thus a balance between lithification by secondary calcification & ambient forces of abrasion & solution.
Calcification makes harder to abrade because more solid smoother & tougher; more difficult to dissolve bec. much smaller mineral/water interface.

Page 103
Mon. 17/1/72
Cape Reamur
On west side of Cape very extensive intertidal to supratidal platform. Chiefly horizontal but a collapse feature forms bay immediately W. of Cape. Some smaller structures have same origin. Some extensive pavement surfaces. Boulder ramp at W. end.
Diagram: of columnar basalt

Page 104
No loose boulders from edge at seaward side to 3-4 chs landward. All loose boulders carried in to form boulder pile. On these exposed faces at seaward edge even no limpets seen but plenty of kelp (Durvillea)

2 Photos: Tele shots of Cape Reamur from McKechnies Craigs
2 Photos: dunes at McKechnies Craigs
2 Photos: Sea between McK. Craigs & Cape Reamur Pt. Fairy Calc. shore & in distance the postglacial dunes.
2 Photos: Julie Percy Is.

Page 105
Diagram: Map of collapsed tumulus (Bay 2)
Diagram: Vertical section of collapsed tumulus (North end of Bay 2)
Relics of Port Fairy L/IGl
Calcarenite here lithified to calcrete. This rock proves
1. The sutures are ancient (pre- L/IGl) and so probably associated with extrusion which was Pen. Glacial.

Page 106
Gap = crack due to breakaway on collapse of tumulus.
Dip – proved by angle of joint planes contrasted with those at ground level (both the vertical & horiz. ones)
As the basalt is highly gaseous (pahoehoe type) such dips so suddenly occurring are significant.
Width of platform – commonly 60 m on microtidal coast (3ft. springs rise) – is notable. Often due to collapse structures which admit sea much further than would otherwise occur. The coast from Pt. Fairy to Cape Reamur is full of collapse structures. The numerous isolated

Page 107
basalt structures protruding from the sea are mostly round or oval tumuli. An unusual feature is the quadrangular
Diagram: Rectangular Bay 3 in rock platform
'lagoon' E of bay on p.105 (See air photo 784-73 W of C.P.) Collapsed lava tunnel or pressure ridge?
These surface features give this coast its unusual character. They no doubt account for the gross irregularity of the terrain inland (same flow) Woodbine Basalt.

Page 108
Diagram: Map of Cape Reamur showing Bays 1 and 2 and a terrace
Diagram: Map of the terrace with notes
Terrace consists of shell grit with some whole shells & basalt boulders. The boulders appear to continue under the sand. Too flat & high with relatively steep sides to be simply

Page 109
an aeolian accumulation. Also this not explain the basalt boulders. Boulder bed at landward end has rocks up to 22" diameter. Similar grit to that thrown amongst shore boulders by storm waves. The shells are from the inter-tidal zone & are here well up in the supratidal.
Test spade hole put down & found the deposit to be deep, stratified & containing a juvenile soil (clay & organic matter accumulation wh. signif. bec. cannot wash from elsewhere as no source for such materials; only higher ground here is the dune which has no soil on the seaward slope.)

Page 110
0"- 8" Light gray shell grit with whitish to pale coloured (natural colours bleached) shells, Loligo guard etc.
8"-15" Black clayey (so more compacted) ditto with limestone pebbles.
15"-20" Mid=gray ditto with small basalt pebbles up to 3" diam.
20"-36"+ Light brownish gray ditto with basalt boulder 4 ½" diam.
Beyond erosive effects of sea now although easily eroded.
Needs 1. Survey to LWL
2. Check auger holes to see if stratification continues across t'ce
3. Radiocarbon datings
of stratified samples consisting of large shells sieved from matrix.

Page 111
Cape Reamur
Diagram: Map of Cape Reamur showing shell grit deposit
Although behind basalt platform & very high boulder bank, shell grit deposit above is eroded by high flying spray which apparently drains N. to structural lagoon.

Page 112
However, the part furthest inland not so affected & is vegetated like that at Bay 2 sampled p.110. This should also be surveyed, sampled & dated.

On W side of Cape on 25/1/72 Rhizomorph cliffs prev. seen were collapsed, having been undercut presumably during winter storms. Many funnels seen, some rough inside with small rhizomorphs. At N end of section thick nodose rhizos stand out of beach while indubitable rhizos of thinner type are in the cliff behind. Thus they are younger, occupying beach only & extend below SL. Sudden change in section as move seaward.

Page 113
Bay 2 Reamur-Pt. Fairy Coast
Photo: Abraded surfaces in woodbine basalt

Photo: Deep penetration of basalt flow by boulder corrosion

Photo : Effective wear of basalt by boulders in potholes

Page 114
3 unlabelled Photos of basalt flow
Pothole 5 feet deep. Smooth sides. Pebble at bottom. Demonstrates in limited measure the corrosion occurring in channels. Apparently no limit to penetration. Keeps going down as long as sufficiently agitated = adequate energy input. Therefore not graded to S.L. However the deeper the erosion the more protected is the bottom. Thus a defined zone in which this feature occurs. Definite upper limit. This limit a function of suff. agitated water which a combination of S.L. + energy status of coast.

Page 115
2 Photos: Rocks plucked by seaweed.
Photo: Bay 3 Rectangular pool due to structure

Photo: View from same place looking across platform. Isolated outcrop in sea is a tumulus.

Page 116
2 Photos: Pot hole with pebbles now well above action of sea. John Clapp says sea no longer reach it. L/IGl?

Page 117
Zones of Erosion
On the shore platform there is a series of zones which require definition & characterization.
A first attempt –
1. Biotic Zone. Kelp & other seaweeds in profusion, calcareous algae, calcareous-tubed worms, mollusca, boring organisms, ascidians, chitons, fish (when tide in). Organisms across whole platform but far richer at this level.
2. Quarrying Zone. Can determine this by direct observation of removal, or by nature of interfaces (e.g. presence of Pt. Fairy Calc. on Cape Reamur coast, iron oxide joint-plane deposits at Pt. Sturt).

Page 118
3. Pothole Zone. This overlaps with quarrying zone but rises higher. It has to be in area of high~~er~~ turbulence of the sea water. For a given platform there is an upper limit to the area in which sufficient energy is present to erode a pothole. Through this zone in a profile normal to the breaker line there is increasing then waning power to achieve this type of corrosion. A graph can express number & depth of potholes in a profile across the platform. No potholes at outer edge where waves sweep the area clear of boulders, which are the essential tools for reaming out potholes.

Note page numbers 119 to 128 are not in the diary

Page 129
4. Pitting Zone. Supratidal and present in highly variable degree. As in limestone or arkose (tafoni) can be a distinctive zone in particular conditions, and so definitive.
5. Boulder Zone Outer platform swept free of boulders. Bank up at back on Cape Reamur coast landward of quarrying & potholing wh. they prevent.
6. Weathering Zone. (Lichens) In zones 1-3 active abrasion is characteristic. This wanes below MLW and also above the zones 3 / 4. In this upper supratidal area normal subaerial weathering becomes dominant & so characteristic. However, at first there is still enough splash & spume to prevent soil formation. However, lichens occur & other organisms that can colonize a bare rock ecology. Rocks in erosion zone are bluish grey but in weath. zone light grey with flecks of iron oxide etc.

Page 130

7. Soil Zone. A fully terrestrial ecology but salt resistant. Coastal flora grows on soil. Rain FW & wind erosion take over from sea
Application to Eustasy
Evidence is present of strong shift of these zones, e.g.
1. Soil zone (7) in the form of lithified terra rossa extends below LWL
2. Weathered rinds (zones 6 / 7) on basalt boulders continue below present SL.
3. Pitted zones (4) extend into present soil zones, as e.g. honeycomb under colluvium on Otway coast.
4. Pothole zone (3) Found in present weathering zone (6) e.g. Pothole above influence of present

Page 131
sea. Proves a change in rel'ship betw. land & sea.
5. Boulder Zone (5) extends in many places beyond the reach of present waves & may pass under coastal dunes. Completed emerged boulder ramps now overgrown by vegetation (e.g. Otways & S. Coast NSW) or covered by colluvium to considerable depth. Also high energy boulder zone covered by sand + veget. (Otways)
Dark
6. Case-Hardening (6) of arkose extended over honeycomb, boulder banks, channel with its boulders and elevated platforms (also parts of present supratidal platform) in Otways.
Changes of S.L. Marked by Zonal Shifts.

Page 132
2 Photos: Bay 2 pothole
2 Photos: Trapped boulders
Photo: Hare's Tail Grass Lagurus ovatus adapted to Cu deficiency
Photo: View from top of dune looking towards Cape Reamur. Basalt platform.
Photo: (N) Inland shore of Bay 2
Photo: NE Shore of Bay 2.

Page 133
2 Photos: View from same dune E along basalt coast.
Photo: View across Bay 2 NE.
Photo: View S from top of sand dune across base of dune to shell grit terrace and basalt platform.
Photo: Shell grit t'ce W of entrance to Bay 2
Photo: View from dune top across basalt platform towards Cape Reamur.
Photo: Shell grit terrace W. of entrance of Bay 2
Photo: Ruler under edge of centre block. Will be free soon, quarried & a pavement begun. Broad joint enlargement in basalt platform at E end of Clapp Beach (E of mouth of Goose Lagoon drain). Prepares way for quarrying & so evolution of a pavement. Centre 9"-12" thick. Rounded Margins.
Labelled: Photo 14; loose

Page 134
Basalt Tumulus
Photo 1: Boy Clapp on Tumulus on edge of Clapp Beach
Photo 2: Pavement developed on platform oppos. Clapp Midden W of outlet of Goose Lagoon drain. oppos. Midden 2 of p.135
Photo: Boulder with Port Fairy Calcarenite shifted 8'6" by quarrying action.
Photo: Site from which boulders shifted. Boulder on left came from X
Labelled: X p.139 f
2 unlabelled Photos

Page 135
Map: from Cape Reamur to Clapp Beach showing 6 numbered bays and 6 numbered beaches

Page 136
21/1/72
Clapp Beach
E end of Clapp Beach (No.5) wide basalt platform.
Pavement 0.5ch diam. and roughly circular formed by plucking & quarrying.
All dips toward pools.
Joint planes enlarged by sand & pebbles. Solution features in splash zone; seaward of that maximal abrasion. See last photo p.133
On basalt pavement opp Midden 2 evidence of recent quarrying
Diagram: Boulder B1 quarried & upturned showing corners X and Z

Page 137
Pt. Fairy Calcarenite attached esp at 2' edge.
Tip X to tip where removed = 8'6". Apart from rounded corners is 14"-19". Tabular as this basalt commonly is bec. of horizontal joints. Say 5'x3'x1.3' = 19.5 c. ft. = 1.64 tons
Geikie 1 ton = 11.9 cu. ft.
Boulder B2 lies on E. side of B1 now altho on W. side when in place
Diagram: of Boulder B2
Isosceles triangle. Corner Z

Page 138
is touching corner Z (SE corner) of B1
Orange colour of the Port Fairy Calcarenite aids matching of moved boulders with the sites from which they came. B2 had to be lifted over in situ rocks 2' high.
During L/IGl rocks weathered. This stripped off during Flandrian Transgression. Boulders on land still show the rinds of weathering. This area not a swamp, or shells would have been leached away.
B2 standing on edge 20" S of corner Z of B1. It was standing against the rocks trapped by B2. The edge on the ground was formerly its W. edge.

Page 139
Boulder 3 8" above pavement is flat rock from which B3 was removed.
On common wall with other rocks shifted. On N side of this platform is rhizomorph therefore must have been dry land, so was Last Glacial
Diagram: Boulder 3 and surrounds
Pt. F. Calcarenite orange coloured except where weathered in wh. case it is off-white. On platform shell fragments & subninella, 2 spp limpets, nerites barnacles, Spirorbis on Dicathais

Page 140
B3 Photo p.134
Diagram of of Boulder #
bryozoa. Note
1. Bec. rhizomorph was once land.
2. Bec. barnacles etc attached in biocoenose, this rock was once in the low tidal zone instead of the present supratidal with Melanerita.

Page 141
3. Leaching shows sea dissolved (& abraded) natural cement in joint plane, lifted rock & shifted it.
4. Because Calcarenite bright orange it has not been exposed long.

5. As Calc. includes pebbles up to 2” diam. the ecology was one of high energy.
6. The fossil zones on the shifted boulder correspond to those on the in situ platform so the orientation (overturned) change & distance travelled can be determined. (8’6”)
Flat sea till breeze blew up waves.

Page 142
Diagram: showing joint infilled with Port Fairy Caklcarenite between two basalt walls
Weathered basalt (in Last Glacial) removed by marine erosion (water, sand & pebbles driven along joints) to expose bluish gray fresh basalt. Weathered basalt ashen gray & 2”-3” rind at most, so much thicker than any weathering under basalt boulders along the horizontal joints. Some apparently not weathered so great difference from place to place.

Page 143
Width of supratidal basalt platform 2ch 55’ = 57 m
Width of beach behind it 1 ch = 20 m
Seaward the platform becomes discontinuous with domes rising out of it, while the kelp line & surf break is at the edge of the basalt a long way further out. In some places there is a boulder bank at the landward end of the platform followed by beach & dune, or direct to a dune (no beach)

Page 144
22-1-72
Port Fairy South Beach
Continued West from where made observations Jan. 1970. Outer reef where Durvillea and surf line. Inside this shallower water with exposed domes of basalt (tumuli). How these areas below LWL? Developed when sea a little lower? Inherited from ancient stillstand?
Long beach (see air photo) prob. a collapse structure filled with sand. Rocks in site along shore dip seaward. Small bay W. of the long beach is due to structure
Diagram: Map showing circular bay & dune with basalt dips seaward

Page 145
On W. side horizontal basalt. Some weathering rims removed along joint planes (photo), an important element in shoreline erosion. Rhizomorphs & paleosols shown weathering during L/Gl. It is “inherited weathering” & not post-Flandrian.
Diagram: Map of circular Bay showing dips of basalt around it.

Page 146
~100 yd further W from bay is channel with large overturned rocks (apparently cast up by sea) with large masses of Galeolaria & calcarenite from L/IGl.
Diagram Map of headland showing channels, tumuli and point ‘X’.
More calcrete in tumulus bec higher, so less abrasion. At X boulders with calcrete & mollusca barnacles, Spirorbis

Page 147
etc. Also fretted rock in storm splash zone.
Dome at landward end of the promontory with more calcrete because not reached so often by the sea. This gradient of erosion related to the sea, proving the sea to be the main factor in the process. Here with open coast & enormous fetch, one would expect no change in tidal range; when higher SL less contrast between poles & equator, so not expect more storminess to erode higher.
Diagram: Cross section of promontory relative to sea level
Maybe these high areas planated

Page 148
or remodelled during the postglacial, but as yet have no way to establish this.
Table: Shoreline Gradients (8 types described: biotic activity; marine activity; tidal activity; meteorologic energy; weathering activity; diagenesis; rock erodability; land plant gradient).

Page 149
Table continued.

Page 150
23.1.72
Characteristics of Basalt Coast Between Pt. Fairy & Cape Reamur

Elevation
1. Supratidal mostly because basalt so hard & tough
Surfaces
2. Inherited ~~Erosion~~ Surface. Last I/Gl calcrete between boulders & in joints shows the platform is essentially that of the L/IGl. Not far different from original flow surface therefore no cliffs.
3. Postglacial Surfaces. From quarrying and from active abrasion by boulders in channels, pools & potholes.
4. Rough Surfaces due to boulder banks stepped surfaces due to quarrying – a function of horizontal joint spacing & marine energy in relation to S.G of rock. If joints

Page 151
too far apart vertically &/or horizontally then blocks too heavy (at S.G. of basalt) to be moved by a given level of marine energy. Similarly if vertical joints & no horizontal joints, then withstand attack of sea as at Cape Reamur.
5. Curved surfaces of tumuli. If eroded or quarried still a dome bec. joints follow surface of structure.
6. Sloping surfaces from collapse structures whether tunnels or tumuli.
Round bays and along channels such as the Back Passage at Port Fairy.

Page 152
7. Flat surfaces. Pavements where joints tight & horizontal to surface & vertical ones to facilitate quarrying. ~20% of the platforms are flat.
Structures
8. Channels in collapse areas & weak areas such as multiple joint planes subtidal to supratidal
9. Pools & potholes comparatively rapid corrosion.
10. Beaches White sand – none in basalt. Prob. from Pt. Fairy Calc.
11. Bays Collapse features with beaches (a) open (b) closed (c) isolated (rectangular Bay 3) (Leura)
12. No cliffs because erosion not far below orig. slope.
13. Excavated joint planes by energetic water & sand & pebbles. Some narrow & appar. recent. Others old with Pt. Fairy Calc. Others due to removal L/Gl. Weathering rinds. Proves reality of abrasion.

Page 153
14. Boulder beds. Outer part of platform stripped & boulders accumulated in (a) Boulder ramps (b) Boulder trains & (C) channels (present & fossil. Some boulder ramps & channel boulders beyond reach of present sea & so evidence of changed rel'ship land & sea. Left by retreating L/IGl sea or postglacial. L/IGl boulders ashen gray rind, comparatively soft, not ring, spots of iron oxide & other

sec. minerals, commonly with lichens. P/Gl boulders bluish gray, no rind, ring no sec. minerals, no epiphytes.
On sites of extra high energy enormous boulders

Page 154
14' – 24' long. W side Cape Reamur boulder bed held fossil in Pt. Fairy Calc. reddened by terra rossa. Weathering rinds.
At Cape Reamur 2-3 chs stripped of boulders. Trapped boulders demonstrate abrasion.
Sediments already mentioned
Sand of beaches
Pebbles in widened joints
Boulders in ramps etc.
15. Shell grit. Large quantities of broken shell characteristic of this coast with high biotic activity (large molluscan population) & hard substrate. Fill joint planes, form beaches (lower part esp.)

Page 155
packing between boulders and vegetated terraces. Beaches concave slopes but terraces flat. In addition to shells, calc. algae, worm tubes, bryozoa, cidaroid spines, squid skeletons etc. Some fragments remanie from L/IGl esp. opercula of Ninella torquata eg. Large promontory W of last house on Ocean drive, S. Beach, Pt. Fairy.

Page 156
24/1/72
S. Beach, Pt. Fairy
Large prom. W of last house on Ocean Dve. Numerous pot holes & inter-boulder abrasion surfaces. Trapped boulders. Elongate tumulus to seaward. To W. is bay fall of rocks & seaweed incl. kelp large boulders 6' x 4' x 4'. Below & between them are deposits of Pt. F. Calc. Fossil shells incl. Dicathais, Subninella limpets.
Sandy island.
Boulder bed passes under dune which very steep here sand island then small bay, then a second sand island, & W. of that more fossil shells This area is SSW of the Port Fairy water tower wh. is readily seen fr. top of dune.

Page 157
Diagram: showing bay, beach, tumuli, joint & channel

Page 158
This joint plane & assoc structures merit further study.
End of this sector is a promontory standing well out, that is the beginning of a very wide platform leading though to Clapp Beach Contrasts with the very broken area just traversed. The areas of tumuli, collapse features etc form sectors of the coast.
From the sand capped island at the begin. of this big platform one can readily see both Griffith Is & Cape Reamur roughly half way along this coast (E-W). Sandy Island stands about 15' above the beach & is vegetated.

Page 159
Tues. 25.1.72
Leura Bay
One tide High 3:14am 0.8 m
Low 11:22am 0.0 m

Kelp helps boulders ashore but not pull much rock off here. Some so plucked but more often just a crust of calc. algae.
Diagram showing beach, dip of basalt, water and boulders

Page 160
Biotic Zone
Photos at 0.0 tide. Kelp (Durvillea) well exposed. White on rocks is myriad barnacles. Many white limpets. Coulerpa, Hormosiro, 2 brown seaweeds, one very light brown (felt-like), one white (hair like) = branching calcareous algae? All exposed for 1+ ch normal to sea. 1 red, 1 encrusting yellow, 1 encrusting green, 1 stick- like but soft, brown & white stems c 1/8" diam. 1 cobalt, red encrusting below LLW mostly but reaching 3" above – overlaps Galeolaria zone.
Photo of pavement of cellular basalt with eroded joint planes. The rich biota tends to anchor the stones, shell & sand that

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would abrade in a higher zone.
Diagram: showing joint structure of basalt block on shore
Estimated to weigh c. 74 tons. Quarried out & lifted up. Say 880 c. ft. @ 11.9 c. ft of basalt per ton (Geikie p. 428) In water (Archimedes Princ.) (18.26 c. ft/ton) would weigh c. 45 tons. Importance of S. G. in quarrying & the volume of water (Archimedes Pr)
This LWOST "platform" only infrequently exposed. Need 0.0 tide & very calm day.
Today a light SE wind

Page 162
Platform above this is supratidal but covered in bad weather when seas heavy.
E. of Reamur Bay c 50% of platform is pavement. Where large number of boulders quarried finish? Some in boulder bank, some under the dunes, some in potholes & pools, some in channels.

0.0m tide and very calm sea allowed a check of the channel on the E side of Cape Reamur (Bay 1) and its morphology in relation to structure. The diagram on page 163 shows the channel is related to flow structure:

Page 163
Diagram: of Bay 1 showing Channel, terra rossa and basalt dips

Page 164
Cape Reamur
Diagram : features of Cape Reamur including two tumuli
Quarried (from tumulus 2) boulders probably under shell grit &/or dunes. Calcrete in joint planes between higher boulders (in situ) of tumulus 2. Shows Pt. Fairy Calc. reached level of top of tumulus estimated ~12' above SL.

Page 165
Height of Pt. Fairy Calc shown also by height of cliffs & thickness reduced in formation of terra rossa. Present sea cannot erode at this level so sea must have been higher during the Postglacial.
Quarrying
1. Stage 1 photo 14 p. 133
2. Stage 2
Diagram: pavement exposed in area from which jointed basalt removed (plucked)
Plucked areas (as above requiring very high energies) at

Page 166
E end of Bay 1 (E side of Cape Reamur). Powerful plucking process necessary to remove blocks from middle. More commonly plucking proceeds landward from the seaward margin.
25/1/72
Sediments
Between Pt. Fairy & Cape Reamur no stream of consequence reaches the sea & there is no quartz in basalt. Beach sand prob from erosion of Pt. Fairy Calc. from among the basalt. Sand from further seaward brought forward as SL rose. A 2nd source is the recently produced shell grit & calcarenite fraction hence the high carbonate content of the sand. Shells

Page 167
contributing are both L/IGl and Holocene The beaches & dunes are stores of this sed.
In W'bool area Tert, marine l'st., Pleist. aeolianite & basalt supply carbonate & depress supply of terrigenous sediment because
a. The basalt is but slowly weathered
b. The limestones develop karst
c. The tuff bed is so absorbent.

Page 168
23.1.72
Port Fairy
Diagram: showing Moyne River, banks, and location of foot and motor bridges also site of sewer excavation.

Page 169
24.1.72
The shells from the drain Holocene because
1. Unoxidized
2. Facies muddy estuary as against open ocean shore of Pt. F. Calc.
3. Muddy seds as ag. clean sand of ocean beach. Diff. dynamics
4. Fossils dominated by Katelysia instead of Subninella/Ninella/limpets
5. Some Katelysia in pairs & little wear as against strong gasterod shell predominance in Pt. F. Calc. where many worn & broken shells. Fairly stable estuary because of basalt substrate. Gross changes not possible. At present time, even with wide & cleared channel not get these species of molluscs growing at Pt. Fairy.
In area where Pt. F. Calc fossils, oxidized shells incl.

Page 170
the index Ninella
26/1/72
Fossil Channel S. Beach Port Fairy See p. 181
Diagram: Map showing Sea, tumulus and fossil channel
Heavy basal boulders with smaller ones above. Shell grit & shells between & above boulders (range 1 m down) Not limited to edible kinds & sizes; much shell grit, minute shells & such

Page 171
Covered with sand; surface flat (not a storm beach ridge)
Roughly graded sediments – boulders to sand.

Juvenile soil – matrix black (organic matter) & clayey in zones of easiest drainage, while under big boulders the sediments are mid-gray to light gray to occasional brown – a colour gradient. No terra rossa as in L/IGl.
Only ~1% shells whole or mostly so. Shell grit as among boulders on present beach. Shells of rock open ocean facies Surface vegetated with grasses, herbs & bushes. High dynamics deposit but not now reached the sea. Compare the boulders under dunes where sea not go now.

Page 172
Dynamics
Boulders -> 1 m diameter (3x3x2 = 12 c.ft. As 11.9 c.ft basalt = 1 ton this about weight of such a boulder). So high dynamics involved. Signif. Of S.G of coastal rocks.
Boulders show weathering – not hard blue-black of eroded boulders on present platform & in channels. A few boulders of calcrete with the basalt ones. Derived from Pt. Fairy Calc.
No secondary deposition altho' carb. So readily dissolved. Sec. dep. char'ic of Pt. F. Calc.
Only juvenile soil developed.
Workers on sandy coasts appear to prefer HWL as a

Page 173
datum bec. more convenient but on rocky coast where impt. zonation betw. LWL & HWL, the former a better datum.
But as long as tidal range given not matter much.
LWOST about as far as water goes but there are minus tides & meteorologically induced minus tides.
Description of shoreline structures & processes requires
1. Profiles of coast & shore
2. Tidal range
3. Energy status
4. Meteorology
5. Lithology type, dip, strike, internal structs
6. Shore structures
7. Zones

Page 174
18/1/72
Mouldens Q., Dennington
Smaller quarry to E has conglomerate at various levels but no mammillary calcite. >2m thick so appar. composite. Mamm. calc. at a number of places in large quarry. May belong to sites lower on slopes. This applies to Middle Is. W'bool & Cape Reamur.
Mult. conglom. prob. has palaeoclimatic significance. Stripped of A horizon or partly so, rubble washed downhill, then stabilize. N. Mallee climate at present provide accum. of calcrete hardpans. Could (1) severe thunderstorm strip or need (2) desiccation of soil? I think (2)
In some places juvenile

Page 175
Holocene soil on calcrete, while in other places there is structureless Tower Hill Tuff. Not aeolian bedded so could be reworked. Some of this has a mammillary (tho' not laminated) surface with a small amt. of carb deposition. Surface much more irreg. than that of mamm. calcite.
Diagram: Rhizomorph with canal c 6' from surface of ground in terra rossa at quarry E of main one.

Page 176
Cannon Hill
Warrnambool

Tower Hill tuff deposited on fossil cliff at Lake Pertobe & shown in railway cuttings was examined because, if tuff c. 7300 y how shells of 6000+ y below it?
The tuff outcrops seen were all unstructured (no aeolian bedding) Structureless soft tuff also in auger holes put down. Tuff could therefore have been washed down later. There was aeolian bedding on Cannon Hill, as seen in a small cave just E of Pertobe Road downhill of cutting noted many years ago.

Page 177
Aeolianite is solid, cross-bedded. W. towards rly stn is lower slope with calcrete + 1'-2' terra rossa. Thinner bec less mature on slope or bec more eroded? Above the terra rossa is up to 10' of unstratified to poorly stratified tuff. Above that is 6"-8" black loam with burrows 6"-12" diam
Diagram: vertical section showing terra rossa, tuff and aeolianite.

Page 178
Pieces of calcrete in tuff therefore washed in. One horizon 12"-18" conglomeratic tuff with calcrete. Terra rossa below it also with pieces of calcrete accum. at bottom of slope.
Nearer station is soft calcarenite with hard carb cover. Sharp junction with solid aeolianite below so interpreted as younger (Last Interglacial).

Page 179
Clapp Beach
Bay 6
Enter locked gate on Princes Hwy at W fence of Clapp's homestead property (Goose lagoon drain betw here & house) then follow tracks past haystack, then across swampy area & up on to rough basalt with many boulders (L/IGl shore platform?) to gate behind dune covered with midden (sampled for C14). Basalt platform with pavements. Also dips in many directions. As go E from gate to outlet of Goose Lagoon drain, a prominent outcrop of basalt sloping steeply seaward is dipping. Tumuli in sea dip into deep water. W of gate to Bay 5 (E of Leura Bay which is 4)

Page 180
where massive basalt on E side dipping into sea is a dip slope of c 15^{o} High dunes behind beach covered with marram. At E end of ~~Leura~~ Bay 5 hummocky sand in front of dunes prac without veg. Due to winter storms?
Some deep potholes. Heavy abrasion.
Clapp Bay (No. 6) has hummocky foredune with sparse vegetation. Tumuli outcrop thro' beach see p. 134 photo 1.

Page 181
Postglacial Fossil Basalt Channel. Extreme W. End Port Fairy S. Beach W of last house in Ocean Drive near change in direction of coast.
See p. 170
Thurs. 27 Jan. 1972
Tides
Daylight saving time (1 hr. forward) but heights corrected to Port Fairy.
H.W. 1:46am 0.8m}
L.W.12:49pm 0.1m} one tide only

Site is drain cut to lead water off area between Holocene coastal dune & L/IGl dune wide flat. Lower area may be former channel landward of basalt reef.
Peg 29 driven in c. 2 chains down drain from fence & old road (extension of Ocean Drive) on left (E) bank of drain.

Survey made from this peg to top of Durvillea zone on outer edge of shore platform = M.L.W.

Page 181 (Should read 182)
C14 2840 ± 80 yr
GaK- 3917
At Peg 29 virtually inland extremity of channel deposit. Sparse shell grit & Subninella shells. Upstream from this only sporadic shell which could have some other origin than channel infill. Here drain 4'6" deep. From here downstream basalt boulders in drain spoil heap. One chain downstream from Peg 29 are boulders in spoil with numerous marine shells attached. From 1.5 ch down boulder bed + shell a well developed deposit. The boulder bed outcrops in the beach backslope The flat sandy ground thro' wh drain cut is out of reach of sea & is cut up for building blocks.

Page 183
Table of Survey results

Page 184
Table continues

Page 185
Drawing: Drain cross-section showing basalt boulders, shell, grit, vegetation.
Fossil coastal channel covered with Flandrian sediments.

Page 186
Surge channel with heavy boulders became a sandy swash flat as sea retreat. With drop in dynamics heavy boulders trapped then pebbles, then shells & grit. Sand & shell grit spread over a wide area so channel many have been a wide one.
Coastal dunes formed since this time. Would have been destroyed if present then. W of this site is a basalt tumulus c 10' above flatland with potholes & plucking proving shift of zones. Also smooth abrasion faces. Five potholes still have boulders in them. Vegetated boulder bank rises up side of tumulus above sphere of present wave action. Shell grit between boulders. Now in weathered lichen zone. Further W is a basalt ramp then change in direction of coast & mobile dunes begin.

Page 187
1. Mr. W. Edwards For key to ~~First~~ Craigs (McKechnies)
16 James St., Port Fairy

2. Mr. John & Joan Clapp, "Dura" Key to Cape Reamur
Princes Highway
W. of Port Fairy

3. Mr. W.B. Sinnott For entry to The Craigs
"Oakvale"
Princes Highway
W. of Port Fairy

4. Laurie and Betty Brown
(Marvin, Stewart, David, Linda, Vivienne)
Gipps St.
Port Fairy
Vegetation includes thorn bushes which die (on ocean side anyway) when sprayed with salt water.

Evidence of plucking is distinct stepping from one horizontal joint plane level to the next as seen on present platforms & proved by observation of Pt. Fairy Calc in relation to lateral movement and

Page 188
over-turning of boulders eg. W. of Clapp Beach.
Moriac
Measured cutting on the Princes Highway, S. side) is about 10 km W. of Mt Moriac

Continued in Notebook 36